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A Summary of Current Program 7/1/66
and Preliminary Report of Progress
for 7/1/65 to 6/30/66

HUMAN NUTRITION RESEARCH DIVISION
of the
AGRICULTURAL RESEARCH SERVICE
UNITED STATES DEPARTMENT OF AGRICULTURE
and related work of the
STATE AGRICULTURAL EXPERIMENT STATIONS

CURRENT SERIAL RECORDS

APR 18 1967

This progress report is primarily a tool for use of scientists and administrators in program coordination, development and evaluation; and for use of advisory committees in program review and development of recommendations for future research programs.

The summaries of progress on USDA and cooperative research include some tentative results that have not been tested sufficiently to justify general release. Such findings, when adequately confirmed, will be released promptly through established channels. Because of this, the report is not intended for publication and should not be referred to in literature citations. Copies are distributed only to members of Department staff, advisory committee members and others having a special interest in the development of public agricultural research programs.

This report also includes a list of publications reporting results of USDA and cooperative research issued between July 1, 1965, and June 30, 1966. Current agricultural research findings are also published in the monthly USDA publication, Agricultural Research. This progress report was compiled in the Human Nutrition Research Division, Agricultural Research Service, U. S. Department of Agriculture, Beltsville, Maryland.

UNITED STATES DEPARTMENT OF AGRICULTURE

Washington, D. C.

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INTRODUCTION

The research reported here presents recent progress in understanding the nutritional needs of normal man and the manner by which these needs can best be met by food. The research involves studies of the absorption, transport, and metabolism of individual nutrients in the body as related to age, activity, and environmental conditions. Studies of metabolic processes and nutritional requirements in man are preceded, guided, and expedited by results from intensive studies on laboratory animals and lower forms of life in which more factors can be controlled and physiological responses can be measured during each stage in the life cycle and during successive generations. The research includes the nutritive and other consumer values of foods as measured by chemical or physical means and by biologic response, and the effects of household practices upon the nutritive value and inherent qualities of foods. Knowledge gained from human nutrition research can be used to influence the food habits and improve the nutritional status of man. It also can influence market demand and in turn the orientation of production of agricultural products.

The program is carried on by the Human Nutrition Division of the Agricultural Research Service of the U. S. Department of Agriculture. It is conducted at the Agricultural Research Center near Beltsville, Maryland, and under contract and cooperative agreement with universities, medical schools, hospitals, and industry. In addition, the Division collaborates with Regional programs of the State Experiment Stations. The Federal scientific effort devoted to this research in Fiscal Year 1966 totalled 41.6 scientific man-years with 34.2 engaged in the program near Beltsville, Maryland, and the equivalent of 7.4 in contract and cooperative agreements. The program is divided among study of:

	Intramural	Extramural	Total
Functions and metabolism of nutrients	13.5	3.3	16.8
Human metabolism and requirements for nutrients	2.5	1.8	4.3
Nutrient value of foods	10.0	1.9	11.9
Other food qualities and consumer use	8.2	.4	8.6

Basic information on human nutrition is needed for conservation and optimal utilization of human and food resources and for nutritional well-being of the population. The Division has contributed to this goal by providing information on nutritional and food needs and on the qualities of foods which influence their usefulness to consumers. Some of these contributions have been summarized here:

Humans respond differently to sugar and starch in the diet. ARS scientists have added to the evidence that human subjects respond differently to starch than to sucrose. In a recent study, young women had higher levels of the enzyme lactate dehydrogenase (LDH) in their blood serum after they had eaten a diet high in sugar for 30 days than after they had eaten a diet high in wheat starch. LDH is an enzyme involved in the conversion of carbohydrate to energy or body fat. High serum levels of this enzyme have been found after some kinds of heart injury. Although none of the serum enzyme levels found in the ARS study was outside the "normal" range, the observed differences due to intake of a particular carbohydrate raise questions on possible long term diet effects of specific carbohydrates.

Safety reaffirmed in long-term feeding of heat-treated fats and oils. Recent ARS contract research has supplied reassuring new evidence that fats and oils introduced into diets from foods fried in deep fat are not likely to affect human health. The findings do not indicate any need for omitting these foods from the diet. Cottonseed oil, corn oil, lard, and hydrogenated vegetable oil were each heated in commercial equipment for deep fat frying for 120 hours at 182° C., a treatment probably more severe than fat would receive in institutional or home cooking. The heated fats and oils were then fed to rats throughout life as 20 percent of the diet. In no case was the life-span reduced or the incidence of any pathological symptoms increased by the heating of the fat or oil.

Polyunsaturated fats stimulate synthesis of cholesterol. ARS nutritionists have uncovered new facts on the metabolism of cholesterol by the body. Dietary corn oil has been found to stimulate the production by the body of cholesterol. Rats were fed diets that contained about 40 percent corn oil or beef tallow--a level of total fat comparable to that consumed by people in the United States. The formation of cholesterol was measured by injecting the rats with acetate, a basic building block of cholesterol, that had been made radioactive so it could be traced through the body. Then the radioactivity of the cholesterol was measured. The cholesterol from both the serum and liver of rats fed corn oil contained much more of the radioactive acetate than rats fed beef tallow. Since polyunsaturated

fats are being suggested by some scientists as a means of reducing serum cholesterol levels and the risk of heart disease, this observation of increased synthesis of cholesterol with high dietary levels of polyunsaturated corn oil re-emphasizes the need for further investigation before drastic dietary changes are recommended.

Guides developed for using less fat in baked goods. Because many consumers need to eat less fat, ARS food specialists have developed ways to prepare palatable baked products with less-than-usual amounts of fat and oils. Palatable muffins and cakes can be made using half the amount of fat in a standard recipe. Tender, flaky pastry and biscuits resulted when one-third less vegetable oil was used and the method for mixing was modified. When solid fats were used, changes in mixing procedures made it possible to reduce the fat one-third in biscuits and one-fourth in pastry. Even though there was some loss of tenderness and flavor, the products were highly acceptable and useful in providing desirable variety for daily meals. Nutritionists in ARS continuously review its consumer publications to be sure they reflect the current recommended practices in food selection and preparation as they relate to the kind and amount of fat in the diet.

New rapid method devised for determining vitamin E components in foods. A new method has been developed by ARS scientists for the analysis in foods of naturally occurring vitamin E components known as tocopherols. Because quantitative determination of the individual tocopherols has been difficult and time consuming, it has been customary to measure them as a group and report the total tocopherol content. But an evaluation of the true vitamin E content of a food cannot be made on this basis, because the individual tocopherols vary widely in their vitamin potency. There is increasing need to know the tocopherol content of food because of the role of vitamin E in fat absorption and the probable increase in the requirement for vitamin E when the diet is high in polyunsaturated fats. In the new ARS procedure, as little as one hundred millionth of a gram of a tocopherol can be detected.

Minerals and vitamins affect body's use of fat. Scientists working in India under a Public Law 480 research grant have reported that minerals and vitamins are important in fat metabolism and that their effect depends on the kind of protein and fat consumed. Diets were patterned after the protein-fat combinations typical of three regions in India--South, Central, and North--and fed to experimental animals, in this case, rats. The diets were "fortified" with vitamin-mineral mixtures to insure an abundant supply of these nutrients. When the fortifying mixtures were omitted from the diets, there was a surprising effect on the levels of cholesterol and serum lipids in the

blood which may have implications for human diets. The diet characteristic of South India contained bean protein and coconut oil. When the vitamin-mineral fortification was omitted from this diet, the blood cholesterol and neutral fat levels increased greatly. The diet of North India is high in animal protein and saturated fat. Omitting the vitamin-mineral fortification from this diet, lowered the blood cholesterol. The diet of Central India is characterized by lower animal protein and fat than in the North and includes some chickpeas and sesame oil. Omitting the vitamin-mineral fortification from this diet had an intermediate effect on blood levels. Studies are being extended for confirmation and explanation.

Guides for consumer use of food commodities. The first four Home and Garden Bulletins in a series of guides for using different groups of foods in family meals were published for the ultimate consumer. These are "Vegetables in Family Meals," "Eggs in Family Meals," "Poultry in Family Meals," and "Cheese in Family Meals." Included in each publication are nutritional importance of the commodity, buying tips, facts on storage, basic methods of preparation, recipes and menu suggestions. The bulletins include many shortcuts to preparation, simple variations of recipes, and ways to reduce the calorie value of the recipes.

These examples demonstrate how research in the Human Nutrition Division assists and can continue to assist the United States Department of Agriculture in its responsibility for producing enough food and a proper assortment of foods to meet the nutritional needs of the nation's citizens within the general framework of their food habits and for guiding consumers in their selection and use of foods.

As a step toward implementation of the recommendations for a National Program of Research for Agriculture made jointly by the Association of State Universities and Land Grant Colleges and the USDA, a section has been added to each of the Areas in this report. It comprises a list of the related publications of the State Agricultural Experiment Stations in addition to those heretofore reported covering the results of USDA and cooperative research. In future years, it is anticipated that information will be available to permit reporting of achievements resulting from State research in a format comparable to the present reporting of the USDA and cooperative research.

A total of 132.3 scientist man-years is devoted to this area of research.

Examples of research underway at the State Experiment Stations include:

Illinois - Mineral Interactions in Human Nutrition. This research seeks to advance understanding about the interaction of minerals in metabolism during induced dietary deficiencies and normal food intake. Human and animal studies are involved. Investigators include but are not restricted to iron, magnesium, calcium, potassium, and phosphorus. Recent findings disclosed that women leading a sedentary life lose iron through perspiration and skin desquamation. The amount lost during winter approaches the average loss per day during menstruation. Rate of dermal iron loss is 3-4 times higher in summer. This finding is relevant to observation by the Food and Nutrition Board of the National Research Council (1964) that losses in sweat were among the avenues ignored in earlier studies on iron. Recommended daily intake of iron should accommodate replacement for all losses.

Vermont - Relationship of Common Dietary Fats to Blood Lipid Levels in Human Subjects. Butter and a corn-oil margarine are compared for effects on lipid components in human serum after intake through a standardized diet. Total diet plan conforms to the daily allowances recommended by the Food and Nutrition Board, National Research Council. Recent progress includes the finding that cholesterol, lipid phosphorus, total fatty acids and triglycerides are higher in serum from subjects that receive the butter fat. The extent of the elevation varies during time intervals of one to five weeks. The significance of differences in effects between kinds of dietary fat is consistent for cholesterol throughout the period. This research is advancing information about the relative effects of saturated and polyunsaturated fat in the diet.

Southern Regional Research - Requirements and Utilization of Selected Nutrients in Preadolescent Children. State Stations in the Southern Region are approaching this research through a coordinated regional effort. The Human Nutrition Research Division of ARS has a contributing project. Plant proteins, B-vitamins, and minerals are among the nutrients being studied with girls 7-9 years of age. A recent contribution from the Georgia Station reports that when the dietary intake of protein and riboflavin are low, there is reduction in requirement for niacin. In these subjects positive nitrogen balance is maintained with 30 percent of the daily dietary protein allowances recommended for this age group by the Food and Nutrition Board, National Research Council. The Louisiana Station reports that different amino acids are control factors for nitrogen retention at different times during short-term control feeding. These findings add to information about dietary requirements for this age group.

Wisconsin - Dietary Factors Affecting Amino Acid Requirement of Man. The ratio of essential and non-essential amino acid intake is being explored as an index to dietary efficacy in meeting protein requirements of man. Recent experiments have kept dietary nitrogen constant,

with part derived from purified nitrogen sources and the remainder from natural foods. Glycine and diammonium citrate were sources of non-essential nitrogen; amino acids patterns of egg, and corn protein were representative of the natural foods. Nitrogen retention increased as the proportion of essential amino acids was elevated in the diet. This retention change occurred with both the egg and corn amino acid patterns, although egg was superior to corn. These findings add to evidence that essential amino acids are important in meeting protein requirements of man. They encourage the use of essential amino acid supplements to enhance nutritional value of a poor-protein natural food source.

Arizona - The Nutritive Values of Southwestern Produced Feeds and Factors Affecting These Nutritive Values. Nutritive values of foods, as consumed, reflect production practices. Components in cottonseed oil are known to produce discoloration in eggs from chickens fed cottonseed meal rations. This research seeks to define these components, characterize metabolic responses to their dietary intake, and discover techniques for reducing egg discoloration. Recent findings showed that the removal of cyclopropenoid fatty acids from dietary cottonseed oil decreases discoloration in the resulting eggs. The presence of cyclopropenoid fatty acids increases in chickens an atherosclerotic syndrome which seems sex dependent. Ferrous sulfate in the ration is effective in reducing egg discoloration even when gossypol is present in cottonseed meal. These findings define one type of feed component that affects nutritive values of eggs, one method of circumventing these effects, and suggest metabolic implications if the components are available in human diets.

Hawaii - A Study of the Nutritive Value of Foodstuffs in Hawaii by Means of Chemical Analyses and Microbiological Assays. Proximate composition, mineral, and vitamin values are determined for a variety of foods used in diets in Hawaii. Locally produced and imported foods are included. These findings are released in bulletins and serve as indices for nutritional value. Most recently, a bulletin on "Composition of Hawaiian Fruits" was released. The bulletin lists experimental procedures, nutritive values, and a statement on comparisons with fruits grown in other places. This research aids the comparison of Hawaiian nutriture with that elsewhere.

Colorado - Effect of Kind and Level of Shortening Upon Quality of Products Baked at High Altitudes. This Station has pioneered in research on food preparation at high altitudes and is a recognized source of information on formula adjustments. Most recent research concerned determination of the levels of five different types of fats required in making acceptable cakes at altitudes of 5,000, 7,500, and 10,000 feet. It was necessary to adjust the amount to be used at each altitude. In addition, formulas were worked out to permit substitution of one type of fat for another within each altitude.

AREA NO. 1: FUNCTIONS AND METABOLISM OF NUTRIENTS

Problem. To clarify the functions and metabolic pathways of nutrients much of the nutrition research must be done with laboratory animals and lower forms of life. Only with animals of short lifespan and on controlled diets can both immediate and long-term physiological responses be measured by various biochemical, biological, and histological methods during every stage in the life cycle and during successive generations. Studies of the morphological structure, biochemical composition, and physiological function of organisms, isolated cells, and cell fragments are needed to extend understanding of nutritional processes. The kinds and amounts of nutrients and energy essential for growth and maintenance of body tissues and for nutritional well-being are influenced by such factors as climate, physical activity, and processes associated with reproduction, as well as by the hormone and enzyme activity that reflects heredity, aging, and sources of stress. Both qualitative and quantitative measures are needed of the extent to which these factors influence nutritional needs, metabolic response to various nutrient combinations, and physiological changes within tissues. Results from investigations with laboratory animals, microorganisms, and cells guide research in human nutrition and help to explain metabolic responses to diet.

USDA AND COOPERATIVE PROGRAM

Current investigations are underway with laboratory animals to determine the effects of nutrients and foods on growth, reproduction, and longevity, on the composition of blood and tissue, and on the structure and functioning of tissues at various stages of the life cycle. Chief variables under study are the kinds and amounts of dietary fats and fatty acids, proteins and amino acids, and carbohydrates. Included also are studies of inter-relationships among nutrients when fed in purified form and when supplied from foods. Studies of cellular metabolism are developing new insights into functions, requirements, and quantitative relationships of nutrients important to the nutrition of man.

The program on the functions and metabolism of nutrients is conducted at Beltsville, Maryland, and under contract and cooperative agreement with private laboratories and at universities and medical schools. The studies require staff with specialized training in nutrition, biochemistry, microbiology, histology, and pathology.

The Federal scientific effort devoted to research in this area totals 16.8 scientific man-years distributed as follows: Lipids 7.8; proteins 2.6; carbohydrates 4.4; minerals 2.0.

PROGRAM OF STATE EXPERIMENT STATIONS

A total of 50.9 scientific man-years is devoted to this area of research.

PROGRESS -- USDA AND COOPERATIVE PROGRAMS

A. Lipids

1. Heated and oxidized fats. Research on fats and oils mildly oxidized by aeration at 60° C. for 40 hours has continued under a research contract with Columbia University at New York City, and has been extended to include information on the response of rats to soybean oil. Mild oxidation has consistently resulted in longer survival for rats fed mildly oxidized olive oil, corn oil, and soybean oil than for those fed the fresh oils. In contrast, survival was similar for rats fed fresh and oxidized fats (lard, beef, chicken, and butter) and did not differ from the results obtained with the three oxidized oils. The results obtained suggest that further research is warranted to determine the cause for the reduced survival observed with the fresh oils.

A report of some of the findings from this research, "Nutritional effects of some fresh and mildly oxidized animal and vegetable fats" was presented to the American Oil Chemists Society in April 1966. A paper entitled "Longer survival of rats fed oxidized vegetable oils" will be presented at the VIIth International Congress of Nutrition in Hamburg, Germany, August 1966.

2. Cholesterol synthesis and dietary fat. The body continuously synthesizes cholesterol, which is essential for normal function but which may be associated with certain pathological conditions. The rate of cholesterol synthesis may be significantly influenced by diet. In recent studies at Beltsville, the influence of type of fat on cholesterol synthesis was investigated. When rats were fed a diet containing 20 percent corn oil, cholesterol synthesis was considerably greater than when the diet contained 20 percent beef tallow. In spite of marked differences in rate of synthesis, no differences were observed in the levels of cholesterol in the serum. A manuscript presenting these data has been submitted for publication.

B. Proteins

1. Proteins versus amino acids. When complete amino acid mixtures are used to replace protein in the diet of rats, less rapid rates of growth are generally found than with high quality protein diets (see 1965 report, 1-B-2, p. 7). In an attempt to explain the differences observed, radioactive tracers were used to study the utilization of glucose by rats fed these two sources of nitrogen. From this investigation, it appears that

the rats that are fed a diet containing protein free amino acids break down glucose differently than those that are fed a diet containing protein. When rats were fed the amino acid diet the direct oxidation of glucose was increased and even though this diet supplies high levels of all known essential nutrients, it fails to maintain normal metabolism. A paper reporting the results of this study has been accepted for publication in the Journal of Nutrition.

2. Immunoproteins and protein status. A project has been initiated to determine the relationship of immunoproteins to protein status and amino acid intake. This project, to be carried out under a research grant with Iowa State University at Ames, will study antibody formation by rats fed proteins from various sources, such as corn, rice, soy, wheat, or egg. The proposed research should aid in establishing the sensitivity of antibody production to protein or selected amino acid deficiencies and further our understanding of the role of food proteins in maintaining a healthy and normally functioning body.

3. Diet and heredity. Although heredity is well recognized as a factor in determining response to diet, there is little information in this area except for inborn errors of metabolism that lead to readily recognized pathology. A major problem in assessing nutritional status of humans is the wide variation in the response of individuals. Basic information on heredity as a factor in dietary response is needed in order to understand differences in the nutritional requirements of individuals. Research underway at Beltsville is providing information on heredity as a factor in the dietary response of inbred rats. Inbreeding our laboratory strain of rats (BHE) resulted in two lines that differ significantly with respect to body size, food consumption, urine protein excretion, and tendency to kidney disease. The results indicated that heredity may be a more important factor than dietary protein in the excretion of protein and in occurrence of nephrosis. Differences in the response to diet occurred within each line, but line 1 rats excreted half as much protein with all diets as line 2 rats. Results of this study point out the need for caution in interpretation of nutrition studies when individual differences may be related to differences in inherited characteristics. A paper presenting the results of these findings has been submitted for publication.

A comparison of the serum protein of the BHE rat with those of two other strains of rats commonly used for nutritional investigations, Wistar and Holtzman, has shown a significant interaction between strain and diet for two of the protein components in their sera, pre-albumin and beta globulin.

4. Dietary protein and in vivo breakdown of urea. Research has been completed under a contract with the University of Chicago at Chicago, Illinois, to determine how the utilization of dietary protein is affected by in vivo breakdown of urea. Diets containing casein, soybean protein, or wheat gluten were fed at three levels (50, 100, and 200 percent NRC allowances) for 8 weeks. In addition, groups of rats on these diets were immunized to an enzyme that is active in the breakdown of urea, an end product of protein metabolism. Food intake, growth, and body composition varied with the kind and level of dietary protein. Similar food intakes and weight gains were obtained for rats fed the high level of wheat gluten or casein but a higher percentage of body fat was observed in the rats fed wheat gluten. Immunization of the rats to urease had little or no effect on growth or carcass composition.

5. Protein and learning. A PL 480 project in India is concerned with the effect of protein on learning performance. A moderate degree of protein deficiency in rats led to a decrease in certain brain enzymes and amino acids and to a lessening in visual discrimination and coordination. The results are consistent with those in a recent U.S.A. report of defective escape and avoidance learning in rats on diets deficient in biotin, a B-vitamin needed for protein synthesis and for utilization of glucose. These findings suggest the need for additional basic studies to determine the effect of diet on neurological development and mental ability.

6. Protein utilization on high rice diet. One way to extend scarce protein supplies is through improving physiological utilization. The relative economy of improving human nutrition with minimal increases in protein content of diets has been little explored. Under a PL 480 grant at Taiwan, Formosa, partial substitution of polished rice with sweet potatoes has been studied in man and compared to supplementation with additional protein and with minerals and vitamins when fed to weanling rats.

Gain in weight of rats during eight weeks was increased about 50 percent by sweet potatoes replacing 10 percent of the rice calories, 100 percent by supplementation with standard mineral and vitamin mixtures, 200 percent by supplementation with soybean meal and fish flour (6 percent additional protein) and 250 percent by the protein and mineral-vitamin supplementation combined. Sweet potatoes or the minerals-vitamins supplement each stimulated food intake. At first feed efficiency (weight gain per unit of feed intake) was markedly higher on the protein supplement than on the sweet potatoes or the minerals-vitamins supplement, but by the end of eight weeks it was much lower and was similar on all diets except the basal unsupplemented rice.

Protein efficiency ratios (PER) (weight gain per gm of protein consumed) for four weeks and also for eight weeks were higher with sweet potato supplementation than without, regardless of whether the diet contained

supplements of minerals and vitamins or of protein or of both. Protein efficiency ratios for the first two or four weeks exaggerated the benefits from protein supplementation alone, compared to eight weeks PER levels from sweet potatoes or from the minerals-vitamins supplement each without additional protein. The standard minerals-vitamins supplement did more to sustain steady high PER over the eight weeks tested than did either the sweet potatoes or the protein supplement to the basal diet which contained 93 percent rice by weight. These results on rat growth and others from the human metabolic studies indicate that protein supplements to human diets may be more or less wasted unless deficiencies in non-protein nutrients of the diets are also corrected.

C. Carbohydrates

1. Heredity. Research with human subjects and with experimental animals is rapidly providing evidence that the utilization of dietary carbohydrate may differ significantly with the type of carbohydrate. A previous report from this Division dealing with the response of two strains of rats, BHE and Wistar, also has indicated that heredity may be a factor contributing significantly to the response to various carbohydrates. Comparison of the responses to age and fasting suggest that the metabolic activity of the liver may be a factor contributing to the shortened lifespan of the BHE rat fed sucrose.

The weight of the liver of the BHE rats fed sucrose increased with age, and was accompanied by a marked increase both in cholesterol and non-cholesterol lipids. In contrast, the Wistar rats seemed to adapt with age to the high cholesterol diet. Liver weight remained unchanged and liver cholesterol decreased significantly. In spite of some relatively high liver lipids in 350 day old BHE rats compared with those found in Wistar rats, survival of BHE rats fed cornstarch or glucose (though not those fed sucrose) was similar to that of Wistar rats fed comparable diets. Liver cholesterol was high in the nonfasted BHE rat fed cornstarch but, in contrast to the sucrose fed rat, decreased on fasting along with a significant decrease in liver weight. In the fasted BHE rats fed cornstarch or glucose, neither cholesterol nor noncholesterol lipid changed with age. Two papers are being prepared for publication, one dealing with the influence of dietary carbohydrate on the composition of the liver and on some serum lipids of BHE and Wistar rats and one dealing with the results of microscopic examination of the tissue of these rats.

A project to be carried out under a recently negotiated research contract with the Hazleton Laboratories at Falls Church, Virginia, also is directed toward increasing our knowledge of the influence of heredity on the response to dietary carbohydrate. In this study fructose, in addition to sucrose and cornstarch, will be the carbohydrates fed. The effects of

changing the type of carbohydrate at 150 days of age will also be investigated. An extensive series of blood measurements will be made in an attempt to find measurements in blood that will predict metabolic differences on some diets due to inherited characteristics.

2. Diet and exercise. To determine the type of diet most effective in a weight reduction program, research has been carried out in cooperation with the University of Maryland at College Park. Two types of diets were fed, one a high fat diet and one a high carbohydrate diet. The diets were fed at two calorie levels, ad libitum and at 65 percent ad libitum intake. One group of rats on each diet was confined to individual cages and was considered sedentary. A second group swam daily for 1 hour. A paper reporting the results for body weight, body composition, organ weights, and serum cholesterol is in preparation.

D. Minerals and Pesticides

Research is being initiated to determine the response to diets containing a mixture of the different types of pesticides currently in use at permissible levels and essential minerals at minimal or excessive levels. Under a grant with the University of Florida at Gainesville, information will be obtained on how these diets affect the activity of enzymes that control body functions. A parallel study under contract with Purdue Foundation at Lafayette, Indiana, will investigate the effects of similar diets on physiological response, particularly on the development of the young and on the maintenance of normal body tissue in growing and adult animals.

E. Nutrient Interactions

Findings from studies to determine the nutritional value of various components of milk emphasize the importance of understanding possible interaction of various dietary components. The diets studied contained milk protein with various combinations of fat, as butter oil or corn oil, and carbohydrates, as lactose or cornstarch. When the diet included butter oil and lactose, calcium absorption by rats was much greater than with butter oil and cornstarch, corn oil and cornstarch, or corn oil and lactose. Retention of calcium, however, did not increase with the increased absorption; the excess calcium apparently was excreted in the urine. A high incidence of kidney stones occurred when the diets contained butter oil and lactose; no kidney stones were found with the diets containing starch. The incidence found with lactose and corn oil was low and did not differ significantly from the cornstarch diets. More research is needed to establish the mechanism responsible for the differences observed. A paper reporting the results of this research is being prepared for publication.

A PL 480 study has provided further evidence that the effects of various dietary components may differ markedly with the food pattern consumed. Diets patterned after the protein-fat combinations typical of those in three regions of India -- North, Central, and South -- were fed to rats to investigate the influence of diet on fat metabolism. Omission of the vitamin and mineral mixtures commonly used to assure adequacy of these nutrients in the diet of the rat resulted in lowering the high cholesterol observed with the high animal protein-fat combination consumed in North India. Omission of these fortifying mixtures caused an increase in serum cholesterol when rats were fed chick pea-sesame oil diet of Central India. Omission from the bean-coconut oil combination of South India resulted in extremely high levels of blood cholesterol and neutral fat. Thus, not only the kind and amount of dietary fat was important and the kind and amount of protein and carbohydrate but also the relative amounts of the minerals and vitamins. These studies are to be extended to confirm these findings and to seek an explanation for the results obtained.

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AREA NO. 2: HUMAN METABOLISM AND REQUIREMENTS FOR NUTRIENTS

Problem. Research in human metabolism is conducted to determine the kinds and quantities of foods and nutrients needed by individuals for nutritional well-being, and the factors that influence nutritional needs. Systematic biochemical and physical observations of persons on self-chosen and controlled diets provide information on the use of nutrients in the body in relation to age, activity and environmental conditions; and on the quantities of nutrients and food energy required by persons of different ages, by those accustomed to different food patterns, or living under different environmental and nutritional conditions. The absorption, transport, and metabolism of individual nutrients and groups of nutrients are investigated. Results of this research aid not only in defining average human requirements for nutrients and for food but also in establishing the lower and upper limits of nutrients and of food combinations conducive to human well-being. Studies also are made of the nutritional status of individuals. Such information is essential for the optimal utilization of our food resources and to all programs for improving nutrition. Application of such knowledge will influence food habits, nutritional status, market demand, and the orientation of agricultural production.

USDA AND COOPERATIVE PROGRAM

USDA research on human metabolism places major emphasis on determining the quantities of nutrients required by persons of different ages on self-chosen and on controlled diets, on measuring the metabolic behavior of individuals with regard to several nutrients at the same time, and on determining the availability and physiological utilization by man of nutrients from diets. The current program deals particularly with factors affecting the metabolism of fat and protein. Other studies seek to establish the range in biochemical response among individuals on controlled and self-chosen diets. Measurements are made on intake of nutrients, output and levels in the blood of metabolic products, and other criteria available in the living organism. Systematic compilation and reevaluation of all available knowledge on subjects of special nutritional significance are made to indicate gaps which should be filled by research, to prevent unnecessary replication of work, and to suggest the most promising areas for new research.

The program is carried out in the laboratories at Beltsville, Maryland, through contracts, grants, and cooperative agreements with universities and medical schools, and through participation in Regional Projects of the State Agricultural Experiment Stations. Nutritionists, biochemists, physiologists, physicians, and statisticians cooperate in the program.

The Federal scientific effort devoted to research in this area totals 4.3 scientific man-years distributed as follows: Nutritional requirements 1.6; nutritional value of foods 2.2; nutritional status 0.5.

PROGRAM OF STATE EXPERIMENT STATIONS

A total of 24.8 scientific man-years is devoted to this area of research.

PROGRESS -- USDA AND COOPERATIVE PROGRAMS

A. Nutritional Requirements

1. Preadolescents. The detailed data on the metabolic responses of 36 girls, 7 to 9 years of age, on controlled diets and studied over a 4-year period under Southern Regional Nutrition Research Project S-28 were compiled into one volume now in press. The data include information on nutrient intake, energy expenditure, skeletal and body surface measurements, blood composition, and nutrient excretion in urine and feces. The data are expected to provide useful guidelines in planning research and in evaluating data as they accumulate in future studies.

2. Adolescents. Laboratory work has been completed on a study to measure the metabolic response of adolescent girls, 16-19 years of age, to a controlled ovo-lacto-vegetarian type diet. The study was conducted under contract with Andrews University at Berrien Springs, Michigan. All 16 girls studied were maintained in positive nitrogen balance while they ate the controlled diet containing a moderate amount of protein (about 64 grams per day). Of particular interest was the positive balance maintained by one subject when she was in a febrile condition. This observation suggests that it is possible to maintain previously healthy individuals on moderate allowances of good quality protein during short febrile periods. Negative calcium balances in a number of the subjects showed that calcium intakes of approximately 1 gram per day were not enough to ensure meeting the needs of these older adolescent girls. The extent of the negative balances indicated that intakes of approximately 1.3 grams per day, as recommended by the National Research Council, probably would have maintained all the subjects in positive balance. The very low positive and slightly negative magnesium balances achieved on intakes of approximately 320 mg per day suggest that a magnesium allowance of at least 300 mg per day might be a realistic recommendation for this age group.

Because of the lack of information on magnesium requirements in all age groups and particularly in the rapidly growing adolescent where the need is likely to be greatest, research contracts for evaluating the magnesium requirement of adolescent boys as related to the level of protein intake

have been negotiated with the University of Wisconsin at Madison and The University of Connecticut at Storrs. Wisconsin boys, 17 to 19 years old, will be studied with three levels of magnesium and two levels of protein. In Connecticut a longitudinal study with 13 to 16 year old boys will be run using two levels of magnesium and two levels of protein. In addition to nitrogen and magnesium balance, the serum levels of magnesium, protein, free amino acids, and of selected enzymes will be studied.

3. Energy requirements and growth. Data on energy metabolism can provide a reliable basis for estimating needs of a nation for food supplies. Under a PL 480 research grant, basal metabolism measurements were obtained on 875 individuals 5 to 56 years of age in Seoul, Korea. Energy metabolism during sleep was about 5 percent below basal and during rest about 25 percent above basal. Basal metabolism was about 10 percent higher in winter (-10°C) than in summer.

Among adult men ages 25 to 56, a basal metabolism of 38 calories per square meter per hour was recorded, compared to 36 calories for soldier recruits under 20, and 41 calories for trained soldiers 20 to 30 years of age. Total daily energy expenditures for men in different occupations, based on respiration measured on the job, were estimated at 2,300 calories for professional (white collar) workers and college students, 2,400 for painters, 2,500 for plasterers, 2,600 for gardeners, 2,700 for bricklayers, 3,300 for soldiers and 3,500 to 3,600 for plumbers and stone workers. Data were obtained also for women in different activities.

Energy metabolism is also an index of muscle mass and capacity for work. Among children changes in level of basal metabolism may be an index of growth and nutritional development. In this study, adolescent girls showed a spurt in basal metabolism (calories per hour) a year younger than the boys did. This spurt reached a peak at age 14 for girls and at age 16 for boys. The average growth spurt in height started soon after the sharp rise in basal metabolism and reached its peak at age 17 for girls, age 20 for boys. Greater weight gains started with acceleration in height, but the steepest weight gains for both groups came in the year following the peak in height. Weight gains leveled off for girls by age 18, for boys by age 22. Thus the age difference between Korean boys and girls for culmination of growth widened from 2 years for basal metabolism to 3 years for height and to 4 years for weight.

B. Nutritional Value of Foods

1. Dietary linoleic acid levels and nitrogen and mineral balance. Data obtained in contract research at the University of Alabama at University, on the metabolic response of 7 young men to a controlled diet with variations in dietary linoleic acid have been published. The results

showed that increasing the linoleic acid content of dietary fat from 10 percent to 26 percent resulted in small changes of doubtful biological importance in serum levels of cholesterol and phospholipids and in no significant change in the retention of nitrogen and minerals. The minerals studied were sulfur, calcium, phosphorus, magnesium, sodium, and potassium.

2. Evaluation of wheat. Work is continuing under contract on the nutritional value of wheat protein. At Michigan State University at East Lansing, the chemical analytical work has been completed in a study in which 12 healthy young men were maintained for 50 days on a controlled diet providing daily approximately 67 grams of protein of which over 90 percent was furnished by wheat products and the remainder by fruit and vegetables. This research was reported at the Fourth International Cereal and Bread Congress, Vienna, May 22-27, 1966. (See 1965 report 2-B-2, p.14). Evaluation and interpretation of the data are continuing.

At the Agricultural and Technical College of North Carolina, Greensboro, data are being collected in contract research with young men on the nutritional value of wheat flour when fed alone or in combination with legumes or other cereals. The results obtained to date indicate that the young men were maintained in positive nitrogen balance on diets supplying 47 grams of plant protein per day when wheat alone or wheat supplemented by pinto beans, rice, or peanuts provided 75 percent (35 grams) of the dietary protein. No significant differences in nitrogen retention by the subjects were noted among the four diets. Serum urea levels fell, an observation which supports the data collected in Michigan. With the exception of lysine (which fell approximately 15 percent), plasma levels of essential amino acids did not change greatly with the wheat diets. The level of nonessential glutamic acid was more than doubled and levels of glycine and alanine rose appreciably. The decrease of alpha-amino-n-butyric acid to trace amounts in the plasma together with the detection of ethanolamine in the urine suggested to the researchers that with these wheat diets more methionine may have been used for synthesis of protein (rather than being metabolized) than was true with the subjects' self-selected meat-containing diets. Portions of this research were reported in April 1966 at the Federation of American Societies for Experimental Biology in Atlantic City and at the American Association of Cereal Chemists in New York.

3. Carbohydrates. Work on the nutritional value of wheat starch as compared to sucrose is continuing at Beltsville. Ten young women, 19-25 years old, ate a controlled diet in which 85 percent of the carbohydrate was provided by wheat starch or by sucrose for thirty-day periods. The most dramatic response to source of carbohydrate was noted in lactate dehydrogenase levels in blood serum. Regardless of the sequence in which they ate the diets, eight of the ten women had elevated levels of this enzyme after eating the sugar diet for 30 days and depressed levels after

eating the starch diet. Two subjects were unresponsive, indicating the possible functioning of genetic factors. Less dramatic but yet significant was the difference between serum levels of alkaline phosphatase (higher on the sugar diet than on the starch diet). Two other serum components which showed significant differences between diets were creatinine (higher on the sugar diet) and total fatty acids (lower on the sugar diet). No significant differences due to dietary carbohydrate were found in nitrogen and magnesium retention, fat excretion and digestibility, or in serum levels of glucose, urea, total protein or protein components, glutamic-oxalacetic and glutamic-pyruvic transaminase enzymes, cholesterol, phospholipids, and glycerides. Portions of these results were reported at the meetings of the Federation of American Societies for Experimental Biology in Atlantic City and of the American Association of Cereal Chemists in New York in April 1966.

A similar dietary study with ten young men (19-23 years old) has been initiated. A number of additional measures of biological response will be included.

Scientists in Israel, supported by a PL 480 Grant from U.S.D.A., have reported evidence that the kind of carbohydrate may have a marked influence on the level of fat and cholesterol in the blood. Adult men and women of various ages, all prone to abnormally high levels of both triglycerides and cholesterol, were fed diets consisting of normal foods which supplied carbohydrates chiefly as sucrose or as starch. With the diets in which starch was the predominating carbohydrate, there was a precipitous drop in the blood triglycerides. Cholesterol levels followed a similar pattern but responded more slowly to dietary changes. Where sucrose predominated in the diet, a marked elevation of blood triglycerides and cholesterol occurred.

4. Metabolic response to size and frequency of meals. At Beltsville, 15 young women ate a uniform nutritionally adequate diet previously described in the 1964 report, 2-A-2, p. 12. When the diet was served in three equal meals per day, the subjects' mean serum cholesterol level was significantly lower than when the diet was served in two small and one large meal per day. When the diet was served in six equal meals per day, the mean serum cholesterol level was intermediate between but not significantly different from that observed on the other two regimens. Serum levels of phospholipids, glycerides, and total fatty acids were not significantly affected by frequency and size of meals. No significant differences among regimens were observed in the retention of nitrogen, calcium, magnesium, and phosphorus, in fat digestibility, or in urinary excretion of thiamine and riboflavin. A manuscript reporting these results is in preparation.

C. Nutritional Status

A study has been initiated to determine the nutritional status of children, 2 or 3 years of age, in low-income families in Hawaii. Under a cooperative agreement with the Consumer and Food Economics and the Human Nutrition Research Divisions, scientists at the University of Hawaii, Honolulu, will investigate the nutriture of some 250 children. Children from low-income families will be compared with those from higher-income families with similar ethnic backgrounds. Biochemical, clinical, and psychomotor tests are being included to assess the nutritional state of the children.

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AREA NO. 3: NUTRIENT VALUES OF FOODS

Problem. The nutritional value of foods to man represents the combined effects of the proportion and form of nutrients as found in single foods or as combined with others in the ordinary diet. Knowledge of these food components is essential for estimating the dietary contribution of individual foods and the nutritional adequacy of diets of population groups. Analyses of foods by chemical and physical means indicate potential nutritive value and are the basis of food composition tables used by nutritionists and clinicians. Continuing analysis of market-available foods is necessary to keep data on nutrient content current with the adoption of new varieties, and production, processing and marketing practices. Data on both cooked and raw foods are needed to determine the effects of household and institution preparation methods upon the nutrients in foods and to derive realistic figures for nutritive value of diets.

USDA AND COOPERATIVE PROGRAM

Foods, representative of various production sites and practices, processing and marketing procedures, are analyzed as purchased from the market and as prepared for eating by the consumer. Analyses are made for many nutrient components including amino acids, fatty acids, minerals, and vitamins. Values for calorie, protein, and fat content are derived from analyses made of the proximate composition. Methods are developed for newly identified nutrients and forms of nutrients; existing methods for known nutrients are improved and adapted for use with different foods.

The research is conducted at Beltsville, Maryland, and under contract and cooperative agreement in the laboratories of universities and industry. Chemists, biochemists, biologists, and statisticians participate in the program.

The Federal scientific effort devoted to research in this area totals 11.9 scientific man-years distributed as follows: Horticultural crops 0.8; animal products 2.0; oilseeds and peanuts 0.3; grain and grain products 6.2; protein and amino acid values 2.6.

PROGRAM OF STATE EXPERIMENT STATIONS

A total of 18.7 scientific man-years is devoted to this area of research.

PROGRESS -- USDA AND COOPERATIVE PROGRAMS

A. Horticultural Crops

1. Fruits. Investigations continue on methods to determine carbohydrate fractions in foods directly and in particular to identify and determine

the sugars. Total solids, total sugars, reducing sugars, sucrose, and acid content were determined in 30 fresh and 3 dried fruits. Bananas, cherries, figs, Thompson seedless grapes and Tokay grapes were highest in total solids, total sugar, and reducing sugars. Bananas were considerably higher, 8.5 percent, in sucrose than any of the other fruits. The fructose content of apples, 6.5 percent, was six times as high as the glucose. Lime juice was highest in acid, 5.6 percent, although cranberries, apricots, raspberries, rhubarb, plums, grapefruit, and sour cherries were high in acidity, ranging 2.0 to 0.9 percent. A manuscript reporting these data has been accepted for publication in the Journal of the American Dietetic Association.

2. Potato products. The substitution of commercially prepared for home-prepared food presents problems to the dietitian and nutritionist in the calculation of nutritive values of diets. Nine potato products in one or more market forms were analyzed both as purchased and ready-to-serve, and except for potato chips, the comparable home-prepared product also was analyzed. Products from dehydrated mixes (au gratin, hash-browned, scalloped, soup) tended to be higher in carbohydrate and ash (15 and 17 percent higher), and lower in protein (27 percent lower) than the home-prepared counterparts. Frozen au gratin and potato soup were more nearly like home-prepared forms than the other commercial forms. For potatoes cooked in fat, variation in different samples of individual brands (french fries, 7 to 16 percent fat; puffs, 9 to 21 percent fat; chips, 30 to 37 percent fat) as prepared for serving or as eaten, was greater than among the brands or market forms.

B. Animal Products

1. Pork. A contract was executed with the University of Missouri at Columbia, for a study of the fatty acids of uncooked, cooked, and cured-cooked pork as part of a program to evaluate the fatty acid composition of cooked meat. The data should provide a basis for estimating the variations in fatty acid content within the carcass (picnic, loin, belly, or ham) and within a specific cut or location (covering, intermuscular, or intramuscular fat in the lean meat). In addition, data will be obtained on the phospholipid and non-phospholipid fractions from the lipid of the lean, since these may be affected differently by cooking and curing plus cooking.

As part of the program to determine effects of the use of pesticides on nutritive values of foods, 16 livers and loins were obtained from hogs raised (4 each) on a pesticide free diet, and diets containing heptachlor, malathion, and DDT. The livers and lean muscle (longissimus dorsi) were samples for pesticide residue analyses and for nutrient analyses including fatty acid composition of the total lipid and of the phospholipid fraction,

thiamine, vitamin A (livers only) and for nine mineral elements. Comparable loins will be cooked to obtain data on the effect of cooking on residues and on the nutrients of these samples. Cooking drippings will be included in the study. This research is being done in cooperation with the Animal Husbandry and Entomology Research Divisions (see 4-B-2).

Studies were completed on the effects of cover fat and degree of marbling of cured hams on their composition and on palatability of the hams, baked and unbaked. In order to obtain comparable cuts, 24 cured and smoked hams were obtained from the University of Illinois at Urbana, representing right and left sides, and selected for high-, medium-, and low-cover fat, and high and low levels of marbling. Baking resulted in higher percentages of lean and lower percentages of subcutaneous fat, but had no appreciable effect on the percentages of intermuscular fat, bone, skin, and waste. The proportion of total solids in the whole ham did not change significantly with baking, the protein and ash percentages increased, and lipids were lost to the drippings (about 25 percent). The percentages of most nutrients in the separable components were higher in baked than in unbaked hams. Few differences in the physical and proximate composition of unbaked and baked hams were found that were attributable to cover fat or marbling (see 4-B-2).

2. Poultry. A study on the possible changes in nutrient composition of eggs and in the palatability of the meat of hens associated with the use of the pesticide, malathion, is on-going under contract at the Food and Drug Research Laboratories, Inc. at Maspeth, New York. Malathion is used to control lice and usually is applied as a dust on the birds and in the pen. For the purposes of this study, to insure uniform exposure to the pesticide by the experimental birds, malathion was incorporated in the diet at levels of 0, 100, and 1,000 ppm. There were some malathion residues in the livers but not the lean meat of birds fed at the 100 ppm. level during preliminary studies. Malathion is rapidly metabolized and it is not anticipated that residues will be present above the 4 ppm. permissible tolerance in meat from the hens fed at the 1,000 ppm. dietary level. The 8-week test period has been completed during which hens were slaughtered at regular intervals to provide palatability samples, and the eggs from all hens were collected. Inspection of early data did not show discernible effects of malathion on body weight, feed efficiency, or egg production during the 8-week period. Approximately half of the nutrient analyses of the eggs have been completed (see 4-B-3).

C. Oilseeds and Peanuts

1. Peanuts. Studies on the effect of the use in the soil of a chlorinated pesticide, lindane, on the nutrients of raw and roasted peanuts were initiated under contract at the Texas Agricultural Experiment Station at College Station. Lindane is not used in the production of peanuts but may

be present in the soil from previous crops. It is known to affect the metabolism of peanuts because of the development of off flavors. For this reason peanuts were selected to study the possible effect of lindane upon nutrient content of plant foods. The nutrients include the individual amino acids and fatty acids, and the B-vitamins, thiamine, riboflavin, and niacin.

2. Soybeans. Researchers in Osaka, Japan, studying the nutrients in tempeh, a product of the mold fermentation of cooked soybeans, have found an increase in values for B-vitamins over those in unfermented soybeans. This research is being done under PL 480 contract. The data showed a net increase in riboflavin, vitamin B₆, and nicotinic acid but not of thiamine. The investigator found increased protein utilization by rats of tempeh over raw soybeans, and an antihemolytic response to tempeh by animals under vitamin E deficient conditions. Previously, the isolation and identification of 6,7,4-trihydroxyflavone from tempeh indicated that it might have the biological effect. The synthesis of the flavone and a comparison of its activity with that of the naturally occurring substance, and with that of vitamin E, were reported. Presumably, the bound flavone occurred in soybeans and in order to be biologically effective was released by the enzymes of the mold. Some of these findings were reported at the 19th annual meeting of the Japanese Society of Food and Nutrition, May 1965; others will be presented at the 7th International Congress of Nutrition in Hamburg, Germany, in August 1966.

D. Grain and Grain Products

1. Wheat and wheat products. Research on the content of nutrients in a wide variety of wheats and wheat products continues at Beltsville and under research contracts with the American Institute of Baking at Chicago, Illinois, and with The Purdue Research Foundation at Lafayette, Indiana. Products are being studied from conventional and air classification flour milling practices and from conventional dough preparation and continuous rise dough procedures.

One hundred samples of 10 consumer available wheat products, including white breads, whole wheat bread, rolls, flour, biscuit mix, doughnuts, and whole wheat cereals, were obtained in each of 10 cities (5 geographical areas) of the United States. Analyses are in progress for proximate composition, B-vitamins, amino acids, and some mineral elements (calcium, phosphorus, magnesium, iron, sodium, and potassium) at the American Institute of Baking.

The samples were analyzed for 14 fatty acids in the extracted lipid fraction at Purdue University. Extraction problems were solved by using combined extracts from solvent treatment and from the acid-hydrolyzed residue after solvent treatment. Thus the entire lipid fraction was obtained for the analyses.

At Beltsville, analyses are being made on these samples for reducing sugars, non-reducing sugars, starch, lactose, and pentosans. Existing methods were adapted for the analyses of wheat products and a manuscript giving the modifications and their analytical variability when used with wheat products has been accepted for publication in the Journal of the Association of Agricultural Chemists.

Procedures have been developed for separation of tocopherols and their analyses by gas chromatography. The procedures include preparation of trimethyl silyl ethers of the tocopherols and their separation with gas-liquid chromatography on specially prepared and packed columns. Retention times were determined for 14 possible tocols and tocotrienols. The results of these studies were applied to partially purified lipids including those of wheat. In whole wheat flour, epsilon tocopherol was the most prominent component; some alpha and beta tocopherols and to a lesser extent zeta-1 tocopherol were present. The quantitative extraction and purification of tocopherols of wheats and wheat products are currently being investigated. A paper on these studies was reported at the meeting of the American Oil Chemists Society in May 1966, and a manuscript is being prepared for publication.

In another phase of this study, samples of the hard wheat grain blends of 5 producing and milling areas, the bread flours from these grains, and the white breads made from the flours, by conventional and continuous dough mix, 20 samples in all, have been obtained. Twenty-eight of the 36 samples of soft and durum wheats, their flours, and products (white cake, crackers, or macaroni) also have been obtained.

2. Wheat fumigation. Research also was continued on possible nutritional implications of repeated use of fumigants on stored wheat. This study is being done in cooperation with the Market Quality Research Division. The wheat samples received treatment periodically during storage with methyl bromide, ethylene dichloride-carbon tetrachloride (3:1), and phosphine. Wheat has been in storage since the summer of 1965 and serious insect infestation in the control wheat has required changes in the fumigation schedule. Five periods, including the initial zero storage period, have been sampled to date. Some 475 samples of fumigated wheat, the untreated controls, their milling fractions (bran, shorts, low-grade flour, patent flour), the bread and roll doughs, and the baked breads and rolls have been received for analyses. To date, analyses for total solids, thiamine, riboflavin, and vitamin B₆ components have not shown distinct differences attributable to effects of fumigation.

3. Rice. As part of investigations of the nutritive value of convenience foods, proximate composition was obtained and energy values calculated for seven rice-containing foods in one or more market forms, both as purchased and ready-to-serve. Plain long-grain white rice (quick precooked, instant precooked, parboiled, and regular) as prepared to serve ranged in food energy per 100 gram portion from 94 to 139 calories. Regular rice was lowest in moisture (65.3 percent) and highest in protein (2.8 percent) among the market forms. Three brands each of canned and dry-pack Spanish rice, and the product from a home recipe, were compared. The ready-to-eat product from the dry-pack contributed higher energy value (average 106 calories per 100 grams) as compared to an average value of 73 for the canned products, and 88 for the home recipe Spanish rice. The corresponding average protein values were 2.4, 1.3, and 1.8 percent. When prepared for serving, canned Spanish rice products were higher in moisture and lower in energy value, fat, and protein than were the home prepared counterparts. Considerable variation in composition was noted among brands of a single product.

E. Protein and Amino Acid Values

1. Compounds of carbohydrate and amino acids. Studies continue on the synthesis of compounds containing amino acids in predetermined molecular configurations. These model systems will provide information on the protein value of amino acids of foods containing carbohydrate when heat processed or cooked. A relatively pure form of the methionine-glucose compound has been prepared containing only about 5 percent free methionine. This compound showed about 40 percent of the microbiological activity for methionine, on a comparable basis. The studies will be continued to prepare the threonine compound and also to prepare compounds with peptides containing glycine and methionine or threonine.

F. General

1. Vitamin E. A review of the vitamin E content of more than 5,000 food and feed items used for human and/or animal consumption was completed and published by the University of Wyoming at Laramie. This review was proposed and partially supported by the Human Nutrition Research Division. A total of 455 references were reviewed and fewer than 40 contained information on individual forms of tocopherols. The review was instigated by the increased recognition given to the importance of the tocopherols in metabolism of polyunsaturated fats and the extent of their use as naturally occurring antioxidants.

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AREA NO. 4: FOOD PROPERTIES RELATED TO QUALITY AND CONSUMER USE

Problem. Food properties are altered by heating, chilling, freezing, aeration, physical manipulation, storage, and other practices which comprise household processes of food handling. The quality characteristics of fruits, vegetables, meats, poultry, dairy products, eggs, fats, flour, and cereals depend upon the chemical composition, physical structure, and biological systems characterizing the raw food and the changes induced by preparative procedures. Relationships should be established between the composition and structure of raw and cooked food and those qualities important to the consumer, including ease of handling, perishability, economy of yield, physical appearance, palatability and nutritive value. Such data are fundamental to developing household and institutional methods of food processing and preparation which permit optimal use of available food supplies and consumption of food for good nutrition.

USDA AND COOPERATIVE PROGRAM

Knowledge of the inherent chemical composition, physical properties, and biological systems in raw and processed foods is obtained to provide basic criteria for determination of those characteristics responsible for palatability and functional behavior of foods during consumer use. Principles are established and improved procedures developed for household food preparation, care, and preservation. The research is carried out along commodity lines such as fruits, vegetables, grain and dairy products, meat, poultry, and eggs. Specialized studies are also made with selected food items for use in the school lunch and other food distribution programs of the Department.

The work is conducted at Beltsville, Maryland, and through contract and cooperative agreement at private laboratories and at universities. Food specialists, chemists, histologists, and statisticians cooperate in this program.

The Federal scientific effort devoted to research in this area totals 8.6 scientific man-years distributed as follows: Horticultural crops 2.9; animal products 2.5; oilseeds and peanuts 1.1; cereals 1.1; guides for consumers 1.0.

PROGRAM OF STATE EXPERIMENT STATIONS

A total of 37.9 scientific man-years is devoted to this area of research.

PROGRESS -- USDA AND COOPERATIVE PROGRAMS

A. Horticultural Crops

1. Fruits. Investigations of the relationship between composition and eating quality of red raspberries of two levels of ripeness have been completed. The berries were of the "Chief" variety. Level of ripeness was based on color; one group was near optimum ripeness and the other slightly past optimum. The slightly overripe berries were scored similar in flavor to the less ripe. They contained less fructose, citric acid, malic acid and alcohol insoluble solids than the less ripe. The major sugars were sucrose--about 50 percent; fructose--about 25 percent; and glucose slightly less than 25 percent. There were significant seasonal differences in both eating characteristics and composition of berries among the three years.

Research was initiated on the effect of chlordane and demeton treatment of the soil upon the palatability and related compositional factors in Earlidawn and Armore strawberries. Both insecticides are effective on contact; demeton also acts systemically. The berries grown in 1965 were evaluated fresh, immediately after freezing, and after frozen storage (0° F.) for three months. Criteria included: panel evaluations for color, texture, and flavor; measurement of ascorbic, citric, and malic acids, fructose, glucose, and sucrose, soluble and total solids, shear force, color, and gas chromatographic examination of head space vapors. The data are being analyzed and will be prepared for publication.

Research was initiated on the effect of the fungicides, captan and ferbam, on the quality of Sunrise and Surecrop varieties of strawberries. Criteria included: palatability; physical measurements of quality; and content of reduced and oxidized ascorbic acid, soluble solids, pectins, alcohol insoluble solids, sugars, organic acids and total solids. Strawberries are being evaluated within a day after harvest.

Research on palatability of blueberries grown in herbicide-treated soil in New Jersey was continued. This work is done in cooperation with the Crops Research Division. For the 1965 crop, blueberries grown on soil treated with diuron and simazine at different rates and times of application were analyzed for total solids, sucrose, glucose, and total and reducing sugars. Correlations with palatability evaluations and pesticide treatment will be investigated.

The effect of herbicide treatment on quality and nutrient content were determined on Red Rome apples from the 1965 crop grown in New Jersey. Diuron, simazine, CIPC (Isopropyl N(chlorophenyl)carbamate) and amitrole were compared with a plastic mulch treatment, a weedy control, and a clean

control. Components being determined include total solids, total dissolved solids, sucrose, glucose, fructose, total and reducing sugars, titratable acids and the mineral elements copper, iron, chromium, zinc, and manganese. Yields of apple flesh and apple peel were calculated. Quality was evaluated by a trained panel and by Kramer shear measurements. The work is in progress.

2. Vegetables. The effect of degree of ripeness upon palatability, and acid and sugar constituents was studied in Hearts of Gold and Hale Best cantaloupes grown in Maryland. Cantaloupes ranged from the hard, green stage to ripe. Flavor intensity was not related to softness or shear value in fully ripe, but they were related in the less ripe cantaloupes. Both flavor intensity and sweetness were greater in the riper cantaloupes, and these were associated with an increase in content of sucrose (about 15 percent) and malic acid (about 20 percent) and a decrease in glucose (about 25 percent).

Research continued on the relation of cell wall constituents to eating quality and dealt mainly with pectin and lipid components of fresh and frozen cantaloupe. PMR-450 and PMR-45 varieties of cantaloupes were obtained from the U. S. Horticultural Field Station at LaJolla, California. The criteria used included microscopic examination of stained sections for qualitative differences in cell structure and constituents; taste panel evaluations of texture; and Lee-Kramer Shear press measurements. Effects of freezing and storage at 0° F. for four and eight months on firmness, tenderness, and sweetness were investigated for the above varieties and for Hale Best variety from two locations in Maryland. The data are being analyzed and a manuscript will be prepared. Manuscripts also are in preparation on some methodological aspects of the histological work.

An investigation was made of relationships between composition and eating quality of six varieties of fresh tomatoes varying in color from yellow to red and believed to vary widely in acid content and keeping quality. The two varieties of yellow tomatoes studied, generally thought to be low in acid, were higher in acid content than were the four varieties of red tomatoes investigated. Considerable amounts of galacturonic acid, not previously reported in fresh tomatoes, were found in all varieties investigated. The varieties which had lower panel scores for intensity of natural flavor also had lower amounts of citric acid, fructose, titratable acids, and soluble solids, and had lower ratios of soluble solids to titratable acids. Panel flavor scores were significantly correlated with soluble solids, pH, and soluble solids-titratable acids ratios. This work was done in cooperation with the Crops Research Division. A manuscript giving the findings has been prepared for publication.

Under contract with the National Cannery Association in Washington, D. C., and Berkeley, California, research on the effect of preparation and cooking on the pesticide residues of selected vegetables is in progress. Pesticide

treatment and residues were within recommended tolerances. Findings show that approximately two-thirds of the DDT residues on field-treated tomatoes were removed by cold water washing and that nearly all the remaining residue was removed by commercial canning and juicing operations and by home preparative procedures. Cold water washing removed about one-half of the Sevin residues from field-treated tomatoes; commercial peeling and canning operations and home preparative procedures removed nearly all the remaining residue. However, no loss of DDT or Sevin occurred during storage of the raw, unwashed fruit at 55° F. for two weeks.

Soaking and cooking procedures for dry beans were investigated to select procedures for pinto, navy, great northern, and kidney beans that will produce tender, palatable products under conditions of large quantity food production. The addition of baking soda in small amounts (0.07 percent) to the soaking liquid shortened the cooking time by about one-half without impairing eating quality. Using the soaking water instead of fresh tap water for cooking the beans helped retain the flavor. The nutritional implications of this procedure will be examined.

Green and yellow dry split peas were found to be interchangeable in formulas for institutional use. Dry split peas should be cooked in lots no larger than 25 portions to prevent breaking up of the peas in the bottom of the saucepot. A variety of uses for split peas in quantity food production were developed, including a split pea loaf, split pea-beef-rice casserole, split pea soup, and split pea chowder.

Reconstitution procedures were developed for dehydrated sweetpotato flakes produced by a new process involving enzyme treatment to permit use of shorter curing times for the sweetpotatoes before processing. One part of flakes to two parts of water by weight produced a more palatable product than did the use of larger proportions of water. This is a similar proportion to that recommended for flakes made by previous methods and used in the National School Lunch Food Buying Guide and quantity recipes. A manuscript presenting these data has been prepared.

3. Potatoes. Research was initiated on changes in the palatability, cooking quality, and related biochemical properties during home storage of potatoes grown in soil treated with PCNB (pentachloronitrobenzene) for protection against black scurf and scab. Potatoes are being evaluated after harvest, after one month's storage at 70° F., and after two and five month's storage at 55° F. Criteria include free phenols, polyphenol oxidase, tyrosine, starch, reducing and non-reducing sugars, citric and malic acids, specific gravity, color, texture, and flavor. Bud and stem ends of potatoes are being evaluated separately. Potatoes grown in Virginia, Minnesota, and Washington were studied in 1965 and work will continue on potatoes from the 1966 season.

An earlier study published during the year indicated that potatoes grown in PCNB-treated soil had higher polyphenol oxidase and cytochrome oxidase activities and lower total phenolic content than potatoes grown in untreated soil. This indicates that PCNB brings about changes in the metabolism of tubers grown in treated soil. In this study Red Warba potatoes were grown in untreated soil and in soil treated with 25 pounds PCNB per acre and Cobbler potatoes grown in untreated soil and in soil treated with 50 pounds PCNB per acre. The Red Warba potatoes were grown in North Dakota in 1960, and the Cobbler potatoes in New Jersey in 1961.

B. Animal Products

1. Beef. Laboratory work was completed for a study of the effect of broiling temperature and degree of doneness upon color and tenderness of seven beef muscles. The muscles studied were: from the chuck, triceps brachii and serratus; rib, longissimus dorsi; loin, longissimus dorsi and psoas major; round, semitendinosus, biceps femoris and semimembranosus. Changes in color and tenderness due to the various cooking procedures are being evaluated in relation to such characteristics of the raw meat as fat, moisture, and myoglobin content, pH, shear press, and Hunter color values. The beef cuts came from beef animals of known history and were representative of those in regular markets.

The work was carried out in cooperation with the North Carolina State University at Raleigh. The cooperators were responsible for selecting the animals, providing carcass data, and making determinations on the raw meat immediately post slaughter. The data are being prepared for publication.

2. Pork. Palatability characteristics of mild-cured, "fully cooked", smoked hams representing three levels of cover fat thickness and two of marbling were not associated with carcass fatness. Hams were trimmed according to accepted commercial practices before curing. Taste panel ratings were obtained for color, juiciness, and flavor of ground lean meat and were sampled at room temperature (72° F.), refrigerator temperature (50° F.), and the customary serving temperature for hot meat (130° F.). Differences in color, juiciness, or flavor were not consistent with fatness in hams sampled as prepared for serving, either processed, "fully cooked" or after baking at 350° F. oven temperature to 130° F. internal temperature. Meat from the baked hams was less juicy and more flavorful than that tested without additional heating. Total cooking losses were about 14.5 percent with about one-half as cooking drip. A manuscript presenting these data has been accepted for publication in Food Technology (see 3-B-1).

A study was initiated of the effect of cooking upon the changes in amount and distribution of pesticide residues in fresh pork loin and shoulders and in hams and bacons cured and smoked by a commercial firm. The hogs were fed rations containing heptachlor, malathion, and DDT. This research is being done in cooperation with the Animal Husbandry and Entomology Research Divisions (see 3-B-1).

3. Poultry. Major emphasis continued to be placed on studies of the effect of cooking time and temperature upon eating quality, safety, and yield of cooked turkey meat. Turkey roasts of light meat and of dark meat were cooked to internal temperatures of 165°, 175°, 185°, and 195° F. by roasting at oven temperatures of 250°, 325°, and 400° F. and by braising at oven temperatures of 250°, 300°, 350°, and 400° F. Higher oven temperatures shortened the roasting time but did not affect eating quality or yield of cooked meat. Braising (oven cooking in a closed container) further shortened cooking times and resulted in juicier meat and lower cooking losses than roasting. Optimum doneness of turkey roasts was achieved at a final internal temperature of 165° to 175° F. for light meat roasts and of 175° to 185° F. for dark meat roasts when roasted and at 165° F. when braised. These data are being prepared for publication.

When whole, stuffed turkeys are cooked slowly, thigh and breast meat are done at a lower meat temperature than when they are cooked more quickly. At oven temperatures of 200° and 325° F., desirable doneness is reached at end-point temperatures in the inner thigh of 165° F. and 180° F. respectively. The time required to reach comparable stages of doneness at 200° F. and 325° F. oven temperatures was 1 hour per pound, or 24 hours for a 24-pound turkey at 200° F., as compared to 7 hours at 325° F. to reach a thigh temperature of 180° F. In the 200° F. oven, the stuffing remained an average of 7 hours in the range of temperatures that permit bacterial growth (45° to 120° F.). Stuffing temperature at the end of cooking was usually under 160° F. and bacteria were recovered from the stuffing during and after heat treatment in 14 out of 16 inoculated turkeys at the end of cooking at 200° F. Cooking at 450° F. in foil reduced the cooking time to about 10 minutes per pound or 4 hours for a 24-pound turkey, but the eating quality of the light and dark meat was not as good as that cooked at 325° F. and, the stuffing did not reach a safe temperature in 20 out of 24 turkeys by the end of the cooking period. Turkeys cooked at either 200° or 450° F. might offer a hazard from certain bacteria if contaminated prior to cooking and are not recommended for use with stuffed turkeys. These data were obtained from research under contract with Purdue University at Lafayette, Indiana. Manuscripts presenting the data have been prepared for publication.

Alternate procedures for thawing and cooking whole turkeys have been developed for use in the School Lunch Program. Cooking of whole turkeys is both time-consuming and a potential health hazard in large quantity food preparation. Also, in School Lunch programs, both time and space

for thawing whole turkeys have been problems. Preliminary findings indicate comparable eating quality and yield from roasting of either frozen or thawed turkey halves or pieces. Cutting turkeys into halves decreased thawing time to about 18 hours, breast pieces required about 24 hours, and legs, 14 to 15 hours in the refrigerator, as compared with several days for thawing a whole frozen turkey. To effect the savings of time in thawing, the pieces must be packaged so they can be separated easily, preferably packed in layers with two sheets of paper between layers.

Research has been initiated to explore the relationship of the protein constituents of turkey breast and thigh muscles to juiciness and texture of the cooked meat. These palatability factors are of major importance in determining consumer acceptance of turkey. Beltsville small white turkeys are being studied fresh and after frozen storage comparable to household practice. Disc electrophoresis is being used to separate protein fractions in water extracts of muscle proteins. If the results prove promising, attention also will be given to further separation and characterization of the proteins.

Palatability data will be obtained on meat from hens treated with malathion in contract research at the Food and Drug Research Laboratories, Inc. at Maspeth, New York (see 3-B-2). Evaluations are made on white and dark meat from birds roasted as fresh market birds and after 6 months storage at 0° F.

C. Oilseeds and Peanuts

1. Flours. Research has continued on quality and food uses for cottonseed, peanut, and soy flours in developing countries, in cooperation with the Agency for International Development. Flours processed by the Northern and Southern Utilization Research and Development Divisions have been evaluated for their quality and potential use by families and community groups in various countries of the world where these plant proteins can be produced. The formulas developed for using the plant-protein flours have been standardized in 5 and 50 portions. A reference handbook containing formulas and recommendations will be prepared.

Cooperative research was initiated at Howard University in Washington, D. C., on food products suitable for some African and Asian countries, using soy and peanut flours, in combination with foods ordinarily available in the developing countries. Students from a number of Asian and African countries will participate and some of the products also will be evaluated by the response of nursery school children. This work will continue at an accelerated rate in an effort to find a number of suitable new items from cottonseed, peanut, and soy flour for feeding to persons in various age groups in various countries.

D. Grain and Grain Products

1. Wheat flour. The viscosity of white sauces made with wheat flours from different geographical regions of the U. S. was studied to determine whether regional differences in flours was a factor in satisfactory preparation of sauces, gravies, puddings, and other dishes depending on flour as a thickening agent. Two flours from the Southern region had greater thickening ability than most of the flours from the West, Southwest, and North Central Regions, as measured by viscometer readings of the sauces at 70° C. and at 24° C. Two agglomerated (instant) flours processed by the steam or hot water method made sauces that were often thinner than sauces made with flours of standard granulation. Sauces became more viscous with the use of fat or sodium chloride and fat in the formula, or with decreases in temperature.

The interchangeability of regular and agglomerated flours for consumer use was compared in different baked products. When the volume of agglomerated flour in the formula was reduced to approximate the same weight as regular flour, all but three baked products were equal in quality to those made with regular flour. Successful baked products were muffins, biscuits, waffles, coffee cake, plain cake, cream puffs, and cookies. Lower quality products were yeast rolls, popovers, and pastry made with agglomerated flour.

Physical tests are in progress on twenty-six flour samples representing all-purpose, bread, cake, cracker, and semolina flours from different sources of known history. Physical tests include amylograph, pH, mixograph, Hunter color, viscosity of a model system, starch swelling, and alpha-amylase.

Research continued on the effects of fumigation of wheat for insect control during storage upon the baking performance of flour for household use and on eating quality characteristics of bread and rolls made from these flours (see 3-D-2).

2. Cracked wheat bulgur. Recommendations for preparation of cracked wheat bulgur were developed for use in consumer food programs such as School Lunch and Needy Family Programs. This food is new to many people in this country and requires special techniques in use to ensure palatable products because bulgur will become hard and tough or soft and soggy if prepared incorrectly. The amount of water used to cook bulgur was found to be basic in determining the kind of cooked product that resulted. Two parts of water to one part bulgur by volume made a cereal that was generally considered preferable to that made from three parts of water to one part of bulgur. Both flavor and texture of the product prepared with the smaller amount of water were preferred. Bulgur cooked in the oven or steamed was generally preferred to that cooked on top of the range.

3. Rice. Medium-grain rice has been difficult for schools to use satisfactorily in their lunch programs because it became gummy when cooked by the usual procedures. Reducing the amount of cooking water 1/3 cup per pound of Nova rice improved the texture of the rice cooked in the oven, a cooking method used extensively in quantity food production. This recommendation has been included in instructions prepared for the National School Lunch Program.

E. Guides for Consumers

1. Food in family meals. New bulletins in this series of consumer publications are "Vegetables in Family Meals", "Poultry in Family Meals", and "Cheese in Family Meals". These are part of a series of eleven bulletins being prepared to help consumers use basic food commodities wisely. The publications bring together research findings on various phases of food preparation; guides for selecting and buying food in the right amount and quality according to expected use and family preference; servings to be expected from amount purchased; modern cooking and storage recommendations; nutritional information; menu and recipe suggestions for family meals.

2. Food for low-income families. As part of the Department's participation in the Federal program to combat poverty, subject matter on uses for different food commodities was prepared for 15 leaflets for a pilot study in Mississippi of families receiving USDA donated foods. Formulas and procedures featuring easy ways to make low-cost, palatable and nutritious food products were developed. Commodities included cereal products--cornmeal, corn grits, bulgur, rice, rolled wheat; dairy products--non-fat dry milk and cheese; poultry and eggs; meat products; dry beans and dry split peas; and peanut butter. This work was done in cooperation with the Consumer and Food Economics Division, ARS, and the School Lunch Branch, Consumer and Marketing Service.

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Line Project Check List -- Reporting Year July 1, 1965 to June 30, 1966

Work and Line Project Number	Work and Line Project Titles	Work Locations During Past Year	Line Project Incl. in Summary of Progress (Yes-No)	Area and Subheading
HN 1	:Nutrients and related substances in foods.	:	:	:
HN 1-13C (Rev.)	:Analysis of foods for fatty acid : composition. **	:Beltsville, Md. : :Knoxville, Tenn.:	No	:
HN 1-20	:Assay and methodological studies of sugars: : and the application of these methods to : the analysis of selected fruits and : vegetables.	:Beltsville, Md. :	Yes	: 3-A-1
HN 1-22	:Effects of fumigation of stored wheat on : vitamin content of grain, milling : fractions, and home-baked products; and : baking performance of flour for house- : hold use.	:Beltsville, Md. :	Yes	: 3-D-2
HN 1-23C	:Nutrient composition of eggs and quality : of the meat from hens treated with : malathion.	:Maspeth, N. Y. :	Yes	: 3-B-2; 4-B-3
HN 1-24C	:Nutrients of peanuts as affected by : lindane treatment of soil.	:College Station, : Texas	Yes	: 3-C-1
HN 1-25C	:Nutrient content of wheat and wheat : products: amino acids, B-vitamins, and : macro mineral elements.	:Chicago, Ill. :	Yes	: 3-D-1
HN 1-26C	:Nutrient content of wheat and wheat : products: fatty acids.	:Lafayette, Ind. :	Yes	: 3-D-1
HN 1-27	:Nutrient content of wheat and wheat : products: carbohydrates, trace mineral : elements, tocopherols, and vitamin B ₆ .	:Beltsville, Md. :	Yes	: 3-D-1
HN 1-28C	:Fatty acids of fat and lean portions of : uncooked and cooked beef and pork.	:Madison, Wis. : :Columbia, Mo. :	Yes	: 3-B-1
HN 1-29	:Comparative studies on hydrolytic and : analytical procedures for the determi- : nation of amino acids in foods. *	:Beltsville, Md. :	No	:
HN 1-30	:Isolation and identification of compounds : of methionine and threonine with other : constituents, formed during heating of : foods. *	:Beltsville, Md. :	Yes	: 3-E-1
HN 2	:Functions of nutrients and their metabolic: : interrelationships.	:	:	:
HN 2-15	:Analysis of records of a rat colony and : development of animals for specific : experimental purposes.	:Beltsville, Md. :	Yes	: 1-B-3
HN 2-24	:The effect on rat carcass composition of : varying proportions of dietary proteins : and carbohydrates. **	:Beltsville, Md. :	No	:
HN 2-36	:The influence of diet on the sequence of : histological changes in two strains of : rats.	:Beltsville, Md. :	No	:
HN 2-37	:The influence of age and diet on enzyme : systems in selected tissues of two : strains of rats.	:Beltsville, Md. :	No.	:
HN 2-38	:Influence of kind of dietary fat and : carbohydrate on the chemistry and : histology of the tissue at different : stages in the life cycle of the rat. **	:Beltsville, Md. :	Yes	: 1-C-1
HN 2-39	:Exploratory investigations on the effect : of diet on body composition of the rat : as determined in vivo or by carcass : analyses.	:Beltsville, Md. :	No	:

* Initiated during reporting year.

** Discontinued during reporting year.

Line Project Check List -- Reporting Year July 1, 1965 to June 30, 1966

Work and Line Project Number	Work and Line Project Titles	Work Locations During Past Year	Progress (Yes-No)	Line Project Incl. in Summary of Area and Subheading
HN 2-40	:The influence of diet on the lipid : metabolism of two strains of rats at : various stages in their life cycle.	: : Beltsville, Md.	: : No	: :
HN 2-41	:The metabolic response of the rat to : diets containing high levels of bromide : residues.	: : Beltsville, Md.	: : No	: :
HN 2-42	:Utilization of amino acid and amide : nitrogen of wheat in tissue protein : maintenance.	: : Beltsville, Md.	: : No	: :
HN 2-43C ^{1/}	:The physiological response of rats to : diets which include different levels of : fats with and without added hydro- : carbon pesticides.	: : Chicago, Ill.	: : No	: :
HN 2-44	:The metabolic effects of pesticide : residues in body fat when the content : and distribution of body fat of rats : fed different diets are altered by : dietary restriction.	: : Beltsville, Md.	: : No	: :
HN 2-45	:Nutritional effects of benzenehexachloride: : in microorganisms. *	: : Beltsville, Md.	: : No	: :
HN 2-46	:Metabolic relationships between carbo- : hydrate and nitrogen.	: : Beltsville, Md.	: : No	: :
HN 2-47	:The manganese and iron nutrition of : <u>Serratia marcescens</u> in relation to the : effects of these elements on pigment : and hematinenzyme metabolism. *	: : Beltsville, Md.	: : No	: :
HN 2-48C	:Utilization of dietary protein as affected: : by in vivo breakdown of urea. **	: : Chicago, Ill.	: : Yes	: : 1-B-4
HN 2-49C	:Nutritional response to diets containing : selected types of fresh and oxidized : fats. *	: : New York, N.Y. : Chicago, Ill.	: : : Yes	: : : 1-A-1
HN 2-50	:The influence of varying dietary com- : position on body composition and metabolic : processes in relation to physical : activity. *	: : College Park & : Beltsville, Md.	: : : Yes	: : : 1-C-2
HN 2-51	:Utilization of energy from diets con- : taining purified protein versus a : simulated mixture of amino acids. **	: : Beltsville, Md.	: : Yes	: : 1-B-1
HN 2-52C	:The influence of sources of dietary carbo- : hydrate fed at different stages of : development on individual variation in : physiological and biochemical response. *	: : Falls Church, Va.	: : Yes	: : 1-C-1
HN 2-53GR	:Basic studies of the biochemical response : of the female and offspring to diets : containing multipesticide components : when selected minerals are fed at : marginal, excessive, or deficient : levels. *	: : Gainesville, : Fla.	: : : Yes	: : : 1-D
HN 2-54C	:Physiological response to diets containing: : multipesticide components when selected : minerals are fed at marginal, excessive : or deficient levels. *	: : Lafayette, Ind.	: : Yes	: : 1-D
HN 2-55GR	:Relationship of immunoproteins to protein : status and amino acid intake. *	: : Ames, Iowa	: : Yes	: : 1-B-2
HN 5-6	:The nutritional value of various : components of milk when fed singly and : in combination to rats. **	: : Beltsville, Md.	: : Yes	: : 1-E

* Initiated during reporting year.

** Discontinued during reporting year.

^{1/} Supported in part by funds from SURD.

Line Project Check List -- Reporting Year July 1, 1965 to June 30, 1966

Work and Line Project Number	Work and Line Project Titles	Work Locations During Past Year	Line Project Summary of Progress (Yes-No)	Incl. in Area and Subheading
HN 5-8	:Lipid biosynthesis as a criterion for : assessing the biological value of : foods. **	: : : : Beltsville, Md. :	: : : : Yes	: : : : 1-A-2
HN 3	:Food quality, preparation, and : preservation.	: : : : :	: : : : :	: : : : :
HN 0-0-1 ^{1/} (AID)	:Household and institutional food uses for : cottonseed, peanut, and soy products in : underdeveloped countries.	:Beltsville, Md. : :Washington, D.C.:	: : : : Yes	: : : : 4-C-1
HN 3-21C	:Preparation factors influencing the : quality characteristics of cooked : poultry meat. **	: : Beltsville, Md. : :Lafayette, Ind. :	: : : : Yes	: : : : 4-B-3
HN 3-22	:Investigations of the constituents in : cells and cell walls of fruits as : related to eating qualities.	: : : : Beltsville, Md. :	: : : : Yes	: : : : 4-A-1
HN 3-24	:Changes in color and tenderness of beef : as influenced by different rates and : extents of heating by broiling.	: : Beltsville, Md. : :Raleigh, N. C. :	: : : : Yes	: : : : 4-B-1
HN 3-26 ^{2/}	:Laboratory investigations of food use : problems in the National School Lunch : Program.	: : : : Beltsville, Md. :	: : : : Yes	: : : : 4-A-2; B-3; : D-2,3
HN 3-27C	:Effect of preparation and cooking on the : pesticide residue content of selected : vegetables.	:Beltsville, Md. : :Washington, D.C. : :Berkeley, Calif.:	: : : : Yes	: : : : 4-A-2
HN 3-28 ^{2/}	:Development of new and improved house- : hold procedures for food preparation as : needed to maintain up-to-date : recommendations for consumers.	: : : : Beltsville, Md. :	: : : : Yes	: : : : 3-B-1; : 4-D-1; E-1,2
HN 3-29	:Quality characteristics and nutrient : composition of foods and food products : treated with pesticides and other : agricultural chemicals in food : production. *	: : : : Beltsville, Md. :	: : : : Yes	: : : : 4-A-1,2,3
HN 3-30	:Effects of the application of pesticide : chemicals during production on the : palatability, composition, and related : biochemical properties of strawberries. *	:Beltsville, Md. : : : : : : :	: : : : : : Yes	: : : : : : 4-A-1
HN 3-31	:Palatability and related compositional : changes during home storage of potatoes : grown with PCNB fungicide treatment. *	: : : : Beltsville, Md. :	: : : : Yes	: : : : 4-A-3
HN 3-32	:Influence of changes in properties of : muscle proteins of frozen, stored turkey : meat on eating qualities of juiciness, : tenderness, and flavor of cooked meat. *	: : : : Beltsville, Md. :	: : : : Yes	: : : : 4-B-3
HN 6	:Human nutritional requirements.	: : : : :	: : : : :	: : : : :
HN 6-7 ^{3/}	:Metabolic patterns of preadolescent girls : maintained on controlled diets. **	: : : : Beltsville, Md. :	: : : : Yes	: : : : 2-A-1
HN 6-8C	:Metabolic response of normal adolescent : boys and girls to a standardized diet : to give information on nutritional : requirements.	: : : : Berrien Springs, : Mich. :	: : : : Yes	: : : : 2-A-2

* Initiated during reporting year.

** Discontinued during reporting year.

^{1/} Supported in part by funds from Agency for International Development, State Department.

^{2/} Supported in part by funds from Consumer and Marketing Service.

^{3/} In cooperation with Southern Regional Project S-28, revised.

1/ In cooperation with Consumer and Food Economics Research Division, ARS, and University of Hawaii.

PL 480 Research Project Check List -- Reporting Year July 1, 1965 to June 30, 1966

Work and Line Project Number	Work and Line Project Titles	Work Locations : During Past Year:	Line Project Incl. in Summary of Progress (Yes-No)	Area and Subheading
PL 480	:	:	:	:
A6-HN-1	:Studies on the nutritive values of protein : and availability of amino acids to human : subjects on a low protein diet.	:Taipei, Taiwan	: No	:
A6-HN-2	:Nutritional studies on rice and sweet- : potato supplementation for the improve- : ment of Formosan diet. **	:Taipei, Taiwan	: Yes	: 1-B-6
A7-HN-4	:Metabolism of ascorbic acid.	:Calcutta, India	: No	:
A7-HN-5	:Biochemical and nutritional studies of : leaf proteins.	:Calcutta, India	: No	:
A7-HN-6	:Effects of protein malnutrition and of : different food sources of protein on : learning performance.	:Baroda, India	: Yes	: 1-B-4
A7-HN-8	:Studies of hormonal regulation of : cholesterol and fat metabolism.	:Calcutta, India	: Yes	: 1-E
A7-HN-10	:Ascorbic acid secretion during lactation.	:Baroda, India	: No	:
A7-HN-14	:The influence of quality and quantity of : dietary proteins on the lipid metabolism.	:New Delhi, : India	: No	:
A7-HN-15	:Protein nutrition and lipid metabolism in : Rhesus monkeys.	:New Delhi, : India	: No	:
A7-HN-17	:Human iodine requirements and iodine : stores in India.	:New Delhi, : India	: No	:
A10-HN-2	:Nutritional studies of carbohydrate- and : fat-induced lipemias.	:Jerusalem, : Israel	: Yes	: 2-B-3
A10-HN-3	:Studies on ultrastructural changes in : essential fatty acid deficiency.	:Jerusalem, : Israel	: No	:
A10-HN-4	:Nutritional evaluation on infants of a : protein mixture from vegetable sources.	:Jerusalem, : Israel	: No	:
A11-HN-1	:Nutritive value of "tempeh".	:Osaka, Japan	: Yes	: 3-C-2
A13-HN-1	:The studies of basal metabolism and energy : expenditures of Koreans in daily life and : work.	:Seoul, Korea	: Yes	: 2-A-3
E15-HN-2	:The effect of chronic administration of : food additives with detergent properties : on lipid metabolism and atherosclerosis.	:Milan, Italy	: No	:
E21-HN-1	:Study on availability and mechanism of : carotene and vitamin A utilization from : different dietary sources and under : different experimental conditions.	:Warsaw, Poland	: No	:
E21-HN-2	:Distribution of goitrogenic substances in : vegetable foods and possible elimination : of their effects. *	:Olsztyn, Poland	: No	:
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* Initiated during reporting year.

** Discontinued during reporting year.

